SM18 activity for the SPS HL-LHC crab cavity cryomodule

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Workflow

The workflow and schedule for the assembly of the SPS HL-LHC cryomodule, as presented by O.Capatina at the cost& schedule Review of the HL-LHC project earlier this year, is first reviewed.

Workflow is the following:

Dressed cavities, closed, no FPC	Production and testing, transportation to CERN	
	Reception at CERN	EN/MME
	Ok for clean room assembly	BE/RF
Cavity train, with beam tube, gate valves, FPC	Assembly in clean room	BE/RF
Cryomodule	Assembly in non-clean area	EN/MME
	Bunker test	BE/RF

SPS tests of crab-cavities will need two different cryomodules, each with a different type of cavities, to be assembled and RF tested in SM18. One of the two cryomodules will be installed in SPS for testing in 2018 with beam, before LS2. Ideally, it will remain in the SPS as long as possible. The second cryomodule does not need to go into the SPS before LS2.

Dressed cavities, RF tested and validated at cold, with closed beam-ports and without power coupler, will be delivered to CERN by JLAB. The first expected cavities are type DQW.

At CERN, EN/MME will perform reception tests (dimensional, visual inspections, check of packaging and shock-logs, etc), then BE/RF will deliver an OK for clean room assembly. No cold test is foreseen on single cavities. Cold tests may be performed, however, in case of doubts concerning transport conditions or observed non-conformities upon reception or upon cryomodule testing.

The clean room activity is under the responsibility of BE/RF. Clean room items for the assembly of the cavity train are under the responsibility of BE/RF (check for non-magnetism of bolts, cleanliness, inventory, etc). EN/MME gives support, in particular for designing tooling and integrating workflow, under the supervision and in agreement with BE/RF and in close collaboration with the team in charge of the clean room assembly activity.

The cavity train is then assembled in the cryomodule, in a non-clean area, by a EN/MME team. Non clean room items, for the assembly of the cryomodule, are under the responsibility of EN/MME. Vacuum vessel, helium expansion vessel and all other sub-items are therefore receptioned by EN/MME.

Storage area for the non-clean assembly of the cryomodule is guaranteed by BE/RF, in time for the reception of sub-items and the assembly work. Storage area should be in proximity of the assembly area.

After validation of the cryomodule assembly (leak checks, electrical tests, pressure tests), the cryomodule is ready for cold RF testing. EN/MME hands over the module to BE/RF, which manages RF tests. The preparation of the M7 bunker for cold tests sees the HL-LHC cryogenic workpackage interfacing with CRG-ME section, but under the management of BE/RF.

During all steps at CERN and for all items and sub-assemblies, BE/RF is considered as the equipment owner. Any decision on non-conformity acceptance is with BE/RF.

Discussion

In case of incidents or non-conformities after tests, it may be necessary to extract a faulty cavity from the cryomodule and test it individually, in order not to undergo the risk of contaminating the neighbouring cavity in the module. BE/RF has the capacity to do a vertical test without stripping the dressed cavity, as already done with the LHC cavities, i.e. without HOM couplers and FPC. A check of the interfaces of the vertical cryostat will be performed and if necessary, matching pieces will be designed and produced. A receipt for HP rinsing of bare and dressed crab cavities and related tooling is being worked out by BE/RF.

Present planning is that cryomodule assembly may start mid 2016; cold testing should be beginning 2017. Baseline today is to assemble in front of the clean room in SM18, although BE/RF is working on finding a new and larger assembly area. No special requirements are presented for the assembly area with respect to the LHC module assembly activity. Space for intermediate storage, crane operation, survey equipment and activity has to be foreseen. Fencing-off of a small area shall be studied. Co-activity with the refurbishment of the LHC cryomodule has to be taken into account. During production of the LHC modules, only 1 module at a time was resting on the rails, but 4 modules were assembled at the same time in the area in front of the clean room. No tent for intermediate clean storage was required for the LHC module assembly.

Co-activity may occur also during cold-testing of the cryomodule. Tetrodes accommodation is not a problem in the available space. The present 400MHz modulator will be transferred to Lund ESS, where it will stay for 18 months; space will thus become free in the RF area.

Visitors may want to be present during RF cold tests, which will be performed by BE/RD/SRF. No external personnel shall use CERN testing equipment. Testing and conditioning of the couplers will be done in BB3.

A support table needs to be studied for the SPS operation, allowing for transverse displacement of the cold, liquid helium filled cryomodule connected to the service module and cold box. It would be good if such a table was tested before operation in the SPS, but since its design requires a complete study of underground integration, the table will not be produced on the timescale of the first cryomodule tests in SM18.

On the matter of Quality Assurance and tracking, EN/MME has a well-defined technical specification from the project; MTF will be used to track all parts manufactured at CERN. Our US partners agree with using a tracking system compatible with MTF. The HL-LHC project office has a MTF support team to create MTF structures as required by the end-users.